CLAIMS

1. A method for calculating aortic flow velocity from the directly or indirectly measured arterial, aortic, or carotid pressure and/or diameter waveform in which the reflected component of the pressure wave is excluded and the peak systolic flow velocity V is calculated from the amplitude P1 of the central pressure waveform using the formula

$$V = \frac{P1}{1.05*C}$$

where C is the aortic pulse wave velocity.

2. A method according to claim 1 wherein the aortic pulse wave velocity is measured directly, estimated from the delay from wavefoot to first systolic peak or shoulder, or taken from published data, then normalised to mean pressure.

3. A method according to claim 1 wherein allowance is made for the reduced aortic velocity in late systole with aging, caused by reduced ventricular contractility in late systole, and attributable to increased left ventricular (LV) load and LV hypertrophy or disease.

4. A method according to claim 3, wherein allowance is made for the further reduction in aortic velocity in late systole, caused by left ventricular weakening and relative change in the heart's pumping action from a flow source to a pressure source.

5. A method according to claim 1 wherein the average velocity in the aorta is calculated for the period of ejection and the period of the cardiac cycle.

6. A method according to claim 1 in which the aortic flow velocity, normalised for that individual, is expressed in terms of volume by multiplying by aortic cross-sectional area and expressed as volumetric cardiac output per minute.

7. A method for determining cardiac output comprising:

(i) determining the pressure waveform in the ascending aorta,

(ii) determining the amplitude (P1) of the initial peak of the aortic pressure waveform,

(iii) determining the aortic pulse wave velocity (C),

(iv) calculating the peak flow velocity (V) using the formula:

$$V = \frac{P1}{1.05 * C}$$

(v) determining the mean systolic flow velocity (Vms) as a predetermined percentage of peak flow velocity (V) to allow for predetermined factors,

(vi) calculating the mean cycle flow velocity Vmc using the formula:

$$Vmc = Vms \times \frac{\text{period of systole}}{\text{period of cardiac cycle}}$$

(vii) calculating the cardiac output by multiplying mean cycle velocity by the aortic cross-sectional area.

8. A method according to claim 7 wherein the pressure waveform in the ascending aorta is determined by recording the carotid pressure or diameter waveform and using this waveform to provide an estimate of the ascending aorta pressure waveform.

9. A method according to claim 7 wherein the pressure waveform in the ascending aorta is determined by applying a generalised transfer function to a calibrated pressure wave recorded invasively on non-invasively in the brachial or radial artery.

10. A method according to claim 7 wherein the amplitude P1 of the aortic pressure waveform is determined by identifying the initial peak or shoulder of the aortic pressure waveform and calculating the height of this peak about the foot of the waveform.

11. A method according to claim 7 wherein the amplitude P1 of the aortic pressure waveform is calculated directly from the radial or brachial pressure waves using the relationship between brachial/radial and aortic augmentation and subtracting aortic augmentation from aortic pulse pressure.

12. A method according to claim 7 wherein the aortic pulse wave velocity (C) is determined by recording the delay in wavefeet between the carotid and femoral arteries.

13. A method according to claim 7 wherein the aortic pulse wave velocity (C) is determined from the age of the patient irrespective of gender.

14. A method according to claim 7 wherein the aortic pulse wave velocity (C) is calculated using the formula:

$$C = 8.52 * Age + 222.$$

15. A method according to claim 7 wherein the mean systolic flow velocity (Vms) is less than 80% of the peak flow velocity (V).

16. A method according to claim 7 wherein the predetermined factors are age, impaired left ventricular contraction and /or heart failure.

17. A method according to claim 16 wherein the allowance for the age factor assumes relatively lower forward flow velocity in the late part of systole after early peak flow.

18. A method according to claim 7 wherein the mean systolic flow velocity (Vms) is determined by assuming that mean systolic flow equals 80% of peak flow to take account of intermittency of cardiac contraction and relaxation.

19. A method according to claim 18 wherein the mean systolic flow velocity (Vms) is reduced to allow for the effects of aging by assuming relatively lower forward flow velocity in the later part of systole after the early flow peak.

20. A method according to claim 19 wherein the age effect reduction is an absolute value of 10% for each decade over age 60.

21. A method according to claim 19 wherein the mean systolic flow velocity is further reduced to allow for the effects of impaired left ventricular contraction on the aortic pressure waveform by absolute 10% if the left ventricular ejection fraction is known to be between 25 to 40% and by an absolute 20% if the left ventricular ejection fraction is known to be below 25%.

22. A method according to claim 21 wherein the mean systolic flow velocity is reduced by 10% if cardiac failure is present and the left ventricular fraction is not known.

23. A method according to claim 7 wherein the period of systole is determined by measuring the duration of ejection from the foot of the aortic waveform to cardiac incisura.

24. A method according to claim 7 wherein the aortic cross-sectional area is measured by ultra-sound.

25. A method according to claim 7 wherein the aortic cross-sectional area is determined from the correlation of body height and weight to aortic cross-sectional area.

26. A method according to claim 25 wherein the aortic cross-sectional area is calculated from the diameter per square meter body surface area (D) using the formula:

$$D = 0.0654 \times Age + 12.63$$

and establishing the square meter body surface area from the body height and weight.

27. A method according to claim 7 wherein the mean systolic flow velocity is reduced to allow for the effective heart rate.

28. A method according to claim 27 wherein the mean systolic flow velocity is further reduced by 0.9% for each beat per minute above 65 beats per minute.

29. A method according to claim 7 wherein the pulse wave velocity is normalised to mean arterial pressure.

30. A method according to claim 29 wherein the normalised pulse wave velocity (C adj)

is calculated using the formula:-

$$C\ adj = C - 7.1\ (100 - mbp)$$

where mbp is the mean arterial pressure.